ANALYSIS AND REDUCTION OF FUEL CONSUMPTION AND EMISSIONS IN INTERNAL COMBUSTION ENGINES

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Abstract: The main objective of this project is to increase millage and reduce pollution in automobiles by using Hydrogen. We all know that water is the only thing that occupies 3/4th of our earth. Water can be used as a powerful fuel by producing hydrogen from it. Each gallon of water can be expanded into 1833 gallons of expandable gas!! In olden days we saw that the automobiles were running with coal as fuel which emits lot of gases that were harmful to the environment. Then the advancement in the automobile sector led to discover the vehicles which can run with petrol/diesel/gasoline as fuel. Here the pollution is reduced to some extent but the uses of vehicles have been increased in day to day life. This is also one of the reasons for global warming. The raising costs of fuels (petrol/diesel/gasoline) become a major threat to the users in this present generation. These fuels may also deplete in a few decades. To meet the requirement we have to increase millage and reduce pollution in the environment. By this project we could overcome these two problems by

1. Boosting up the efficiency by using HHO gas.
2. Reducing emission of harmful by-products from automobile.

***KeyWords*: HHO gas, Pollution, Emission, Global Warming, Millage etc.**

1. INTRODUCTION

Nature required more than 200 million years developing all of the oil below the earth's surface. Mankind require just 200 years consuming half of that. If current rates of consumption continue, the U.S. Department of Energy says that the world's remaining oil would be exhausted in 40 years. About 60 percent of the oil the world consumes powers transportation vehicles and half goes to passenger cars and light trucks. As oil resources dwindle and oil becomes prohibitively expensive to locate and extract, mankind will replace petroleum as a primary source of power because alternative forms of energy simply will be more economical. Still, burning less gas in our vehicles will affect the pace at which oil is consumed. Even more important, fuel conservation will impact the demand for oil. And that has meaningful political, technological, and environmental consequences. Transportation vehicles produce most of the key chemicals that pollute the air, causing smog and health problems. Air quality is poorest in developing industrial nations. Vehicles with higher fuel economy may produce less pollution over time than vehicles with lower fuel economy. Global Warming is also related to automotive exhaust emissions. Greenhouse gases trap heat and contribute to global warming by keeping a significant percentage of infrared radiation from escaping into space.

The concentration of greenhouse gases, especially CO2, has increased substantially since the beginning of the industrial revolution. Natural greenhouse effects contribute to global warming, but the National Academy of Sciences says the increase over the past 150 years is due in large part to human activity. The main consequence of exhausting of fuels is hike in fuel price. People are worried very much as the prices of fuel are going up drastically and they are also struggling to cut down their daily fuel expenses. Our country has the privilege for levying more tax on fossil fuels for profits. In order to reduce the atmospheric pollution emitted by automobiles, control devices are being incorporated in the vehicles in many countries. This has resulted in a reduced vehicle mileage to the extent of about fifteen percent. Without the introduction of new technology, any further reduction in emission levels would be expected to extract payment in the form of further fuel economy losses. Usage of vehicles is increasing day-to-day. Increase in vehicles will lead to fuel scarcity in the mere future. These lead researchers to think about alternate fuel that can be utilized for the vehicles

A number of factors affect the fuel consumption of an ordinary vehicle, for example driving behaviors such as acceleration, speed, traffic and road conditions, vehicle conditions etc. Concerning the above factors, fuel price and environmental pollution the performances of an ordinary Internal Combustion Engine (ICE) has to be improved. In practice, ICEs used in vehicles are divided into three categories, i.e. Spark Ignition Engine, Diesel Engine and Gas Turbine Engines. Spark Ignition Systems are widely used in automobiles. Here, petrol (gasoline) and diesel are highly used as the preliminary source of fuel [1-2]. Throughout this research we have only focused on the spark ignition systems which use gasoline as the preliminary source of fuel. In spark ignition systems an amount of vaporized fuel is mixed with an appropriate amount of air and these engines are designed to ignite the air-fuel mixture at the optimum instant.

The flammability range of Gasoline is 1.4% to 7.6% of the volume. Hence, every pound of air should mix with 0.224g to 1.216g of vaporized gasoline in order to have a better combustion. If more vaporized gas is fed into the system, it may leave some unburned/partially burned fuel in the piston chamber as shown in Fig. 1. This unburned/partially burned fuel is one of the main pollutants that originate from conventional Hydrocarbon fuel. Carbon Monoxide (CO), Oxides of Nitrogen (NOX) and smoke are the main pollutants produced by this process. The unburned/partially burned fuel causes in increasing the exhaust emission of an engine which results in reducing the efficiency of the engine [3-4]. In order to decrease the amount of exhaust emission it is necessary to increase the thermal efficiency of the engine.

1.1 FIRE FROM WATER:

Fire from water! Yes it is true and known for quite a while that water is made up of hydrogen and oxygen and can be easily separated into its components. Which when recombined releases a tremendous amount of energy. Controlling it is the key. There was stories about running cars on water well that is just one of the many applications, Professor Yul Brown's discover Browns gas and makes stories facts.

1.2 BROWN GAS OR HHO GAS:

"The discovery of Brown " Born in 1922 in Bulgaria, Yull Brown went to Australia in 1958 as an electrical engineer with a deep belief that Jules Verne‟s vision of "There is fire in water", could be realized. He worked as an unknown laboratory technician until he could develop his own laboratory. By 1978 Professor Yull Brown was being described by The Australian Post as "the most talked about inventor in Australia today". He discovered in the early 1970's a proprietary method of water electrolysis that yields a non-explosive mixture of hydrogen and oxygen gas in the precise atom-to-atom ratio of two volumes of hydrogen to one volume of oxygen [2].

Professor Yull Brown discovered that hydrogen and oxygen gas can be safely mixed if that ration is strictly maintained. The result is Brown's Gas, a hydrogen and oxygen mixture that can be economically generated, compressed, and used safely. In Professor Brown's process, the hydrogen and oxygen gases are immediately and intimately mixed at exactly the right ratio (the scientific term is "stoichiometric mix"). Brown's Gas is produced within an electrolysis cell, without membranes and with safety, invented by Professor Yull Brown.

1.3 AIR QUALITY PARAMETERS AND ASSOCIATED HEALTH EFFECTS:

1.3.1 Carbon Monoxide:

Carbon monoxide (CO) is an odorless, colorless gas that is formed naturally due to emissions from the sea, combustion processes (bush fires) and oxidation of methane in the atmosphere (as a result of organic decomposition).

As an anthropogenic (man-made) source, CO is a product of a combustion process where there is limited oxygen supply, typically occurring in internal combustion engines. CO is easily oxidized to Carbon Dioxide in the presence of the concentrations of oxygen found in the atmosphere, and as such it generally does not present a problem unless the space or oxygen concentration is confined.

In the body, CO combines with hemoglobin to form carboxy hemoglobin. Hemoglobin has a greater affinity for carbon monoxide than oxygen (by a factor of 200). As such, when it is inhaled, it reduces the uptake of oxygen by the lungs. This process is reversible, and providing exposure to carbon monoxide is reduced, the detrimental effects of exposure will be remedied within a matter of hours. Short term effects of acute exposure to CO include headaches, nausea and lethargy. However, these are generally not reported until concentrations of carboxy hemoglobin (formed when CO is taken up by the blood) are in excess of 10% of saturation. This is approximately the equilibrium value achieved with an ambient atmospheric concentration of 70 mg/m3 for a person engaged in light activity. However, there is evidence that there is a risk for individuals with cardiovascular disease when the carboxy hemoglobin concentration reaches 4% and the World Health Organization (WHO) recommends that ambient concentrations be kept from exceeding the 4% saturation level.

1.3.2 Particulate Matter:

Total Suspended Particulate (TSP) consists of course and fine particles. In the atmosphere, particles range in size from 0.1 μm to 50 μm. Even without human activity, the atmosphere contains particles from sources such as wind-blown dust, volcanoes, fires, sea salt, pollens and bacteria. With regard to human activity, industry is usually the largest producer of particulates. Atmospheric particulates include primary and secondary pollutants.

1.3.3 Sulphur Dioxide:

Sulphur dioxide is an acid gas that can have harmful effects on the respiratory system as well as on vegetation and building materials when it combines with moisture in the atmosphere to become “acid rain”.
Exposure to sulphur dioxide is more common due to incidents of “plume grounding” (when a pollutant plume is not dispersed and hits the surrounding land) from power stations burning high sulphur coal. These typically occur in short episodes, and this is reflected in the short averaging times (10 minute and 1 hour) given for the sulphur dioxide air quality goal (as specified by the National Health and Medical Research Council)

1.3.4 Hydrocarbons (Volatile Organic Compounds):

Natural emissions, such as those generated by eucalypts, account for over 50% of Volatile Organic Compound (VOC) emissions in many environments. However in an urban environment, emissions are usually dominated by vehicle emissions, as the biogenic sources are generally located away from urban centers. Sources of volatile organic compounds (VOCs) include fugitive vapour emissions of lubricants and fuel, as well as the products of incomplete combustion of fuel. The amount of evaporative emissions is related to the diurnal temperature.

1.3.5 Oxides of Nitrogen:

Oxides of nitrogen (NOX) include nitric oxide (NO) and nitrogen dioxide (NO2). All combustion processes in the presence of air produce nitric oxide, and concentrations are increased under high pressure.

NO is produced naturally by microbial activity, and also by lightning storms in significant amounts. Anthropogenically, NO is formed in the atmosphere by combustion processes, particularly high temperature (>1000°C) processes such as those occurring in power stations and within the internal combustion engines of motor vehicles. Typically, NO will constitute between 5% and 10% of total NOX emissions from combustion sources.

1.3.6 Ozone (Photochemical Smog):

Photochemical smog is a type of air pollution produced when sunlight acts upon motor vehicle exhaust gases to form harmful substances such as ozone (O3), aldehydes and peroxyacetylnitrate (PAN). Ozone causes breathing difficulties, headaches, fatigue and can aggrevate respiratory problems. The peroxyacetylnitrate (CH3CO-OO-NO2) in photochemical smog can irritate the eyes, causing them to water and sting.

2. LITERATURE REVIEW

2.1Use of H2 as IC Engine Fuel:

In the early years of the development of internal combustion engines, hydrogen was not the “exotic" fuel that it is today. Water splitting by electrolysis was a well-known laboratory phenomenon. Otto, in the early 1870s, considered a variety of fuels for his internal combustion engine, including hydrogen. He rejected gasoline as being too dangerous. Later developments in combustion technology made gasoline safer.

Most early engine experiments were designed for burning a variety of gases, including natural gas and propane. When hydrogen was used in these engines it would backfire. Since hydrogen burns faster than other fuels, the fuel-air mixture would ignite in the intake manifold before the intake valve could close. Injected water controlled the backfiring. Hydrogen gave less power than gasoline with or without the water.

2.2 Effects of HHO on Spark Ignition Engine :

Ammar A. Al-Rousan et al. conducted performance test on the single cylinder spark ignition air cooled 197cc engine and HHO production system was designed, constructed, integrated with a gasoline engine. i.e. the output of fuel cell connected to the intake manifold of the gasoline engine and performance test was performed before and after attaching fuel cell with constant load and variable speed (from 1000 to 2500 rpm) and result shows that brake thermal efficiency increase about 3% for cell B and 8% foe cell C and 20 to 30% reduction in fuel consumption and exhaust temperature.

And research showed that use of HHO in petrol engine enhances combustion and optimum surface area needed to generate enough amount of HHO is about twenty times that of piston surface area also, the volume of water needed is about one and half times engine capacity.

3.0 PRODUCTION OF HHO GAS :

3.1Electrolysis of Water:

Electrolysis of water is the decomposition of water into oxygen and hydrogen gas due to an electric current being passed through the water. The reaction has a standard potential of −1.23 V, meaning it ideally requires a potential difference of 1.23 volts to split water. This technique can be used to make hydrogen fuel (hydrogen gas) and breathable oxygen; though currently most industrial methods make hydrogen fuel from natural gas instead. A DC electrical power source is connected to two electrodes, or two plates (typically made from some inert metal such as platinum, stainless steel or iridium) which are placed in the water. Hydrogen will appear at the cathode (where electrons enter the water), and oxygen will appear at the anode.

Assuming ideal faradic efficiency the amount of hydrogen generated is twice the amount of oxygen, and both are proportional to the total electrical charge conducted by the solution. However, in many cells competing side reactions occur, resulting in different products and less than ideal faradic efficiency. Electrolysis of pure water requires excess energy in the form of over potential to overcome various activation barriers. Without the excess energy the electrolysis of pure water occurs very slowly or not at all. This is in part due to the limited self-ionization of water. Pure water has an electrical conductivity about one millionth that of seawater. Many electrolytic cells may also lack the requisite electro-catalysts. The efficiency of electrolysis is increased through the addition of an electrolyte (such as a salt, an acid or a base) and the use of electro catalysts.

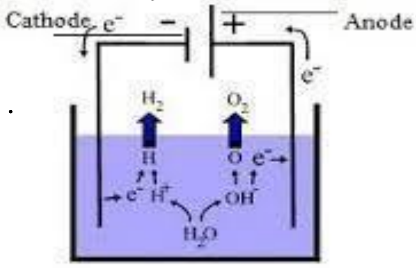

Fig1.0: Electrolysis – splitting of water and producing hydrogen and oxygen gas

Currently the electric processor is rarely used in industrial applications since hydrogen can be produced more affordably from fossil fuels. The same half reactions can also be balanced with base as listed below. Not all half reactions must be balanced with acid or base. Many do, like the oxidation or reduction of water listed here. To add half reactions they must both be balanced with either acid or base. The acid-balanced reactions predominate in acidic (low pH) solutions, while the base-balanced reactions predominate in basic (high pH) solutions.

Cathode (reduction): $2 H_2O (l) + 2e^- \rightarrow H_2 (g) + 2 OH^-(aq)$

Anode (oxidation) : $4 OH^- (aq) \rightarrow O_2 (g) + 2 H_2O (l) + 4 e^-$

Overall reaction: $2 H_2O (l) \rightarrow 2 H_2 (g) + O_2 (g)$

Water electrolysis is also used to generate oxygen for the International Space Station. Hydrogen may later be used in a fuel cell as a storage method of energy and water.

3.2 Oxyhydrogen:

Oxyhydrogen is a mixture of hydrogen (H_2) and oxygen (O_2) gases. This gaseous mixture is used for torches to process refractory materials and was the first gaseous mixture used for welding. Theoretically, a ratio of 2:1 hydrogen: oxygen is enough to achieve maximum efficiency; in practice a ratio 4:1 or 5:1 is needed to avoid an oxidizing flame. The term Brown's gas refers to oxyhydrogen with a 2:1 molar ratio of H_2 and O_2 gases, the same proportion as in water. It was named after Yull Brown in 1922 in Bulgaria, Yull Brown went to Australia in 1958 as an electrical engineer with a deep belief that Jules Verne‟s vision of "There is fire in water", could be realized. He worked as an unknown laboratory technician until he could develop his own laboratory. By 1978 Professor Yull Brown was being described by The Australian Post as "the most talked about inventor in Australia today". He discovered in the early 1970's a proprietary method of water electrolysis that yields a non-explosive mixture of hydrogen and oxygen gas in the precise atom-to-atom ratio of two volumes of hydrogen to one volume of oxygen.

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3.3 Properties of HHO Gas:

Oxyhydrogen will combust when brought to its auto ignition temperature. For the stoichiometric mixture, 2:1 hydrogen:oxygen, at normal atmospheric pressure, auto ignition occurs at about 570 °C (1065 °F). The minimum energy required to ignite such a mixture with a spark is about 20 microjoules. At standard temperature and pressure, oxyhydrogen can burn when it is between about 4% and 95% hydrogen by volume. When ignited, the gas mixture converts to water vapor and releases energy, which sustains the reaction: 241.8 kJ of energy (LHV) for every mole of H_2 burned. The amount of heat energy released is independent of the mode of combustion, but the temperature of the flame varies. The maximum temperature of about 2,800 °C (5,100°F) is achieved with an exact stoichiometric mixture, about 700 °C (1,300 °F) hotter than a hydrogen flame in air.When either of the gases are mixed in excess of this ratio, or when mixed with an inert gas like nitrogen, the heat must spread throughout a greater quantity of matter and the temperature will be lower.

4.0 EQUIPMENT SET UP:

4.1 Engine Specifications

Experiment was conducted on a two wheeler, Mahindra Centuro

Type : Motor Cycle

Spark Ignition Engine

OHC based engine

Cycle : 4-Stroke, Air cooled

No. of Cylinder : 1

Compression Ratio : 9.6:1

Engine Displacement : 106.7 CC

Rated Output: 8.5 PS @ 7500 rpm

Maximum Torque : 8.5 NM @5500 rpm

Ignition Timing : Variable

4.2 HHO Kit :

An HHO kit or Brown gas generator is an interesting technology. It uses electrolysis process to split water (H_2O) into its base molecules, 2 hydrogen and 1 oxygen molecule."

4.3Key Features:

Increase in mileage of vehicle up to 40% and more.

Increase pick-up of vehicle.

Increase the life of engine oil more than 2 to 3 times.

Better smoother running engine.

Remove carbon deposit and prevent future carbon buildup.

Reduce knocking of engine.

Reduce the operating temperature of the engine.

Decrease the oil consumption of the engine.

4.4 Description of Parts in HHO Kit :

4.4.1 HHO Cell: An HHO or Brown gas generator is an interesting and often misunderstood technology. The Brown gas generator uses electrolysis to split water (H_2O) into its base molecules, 2 hydrogen and 1 oxygen molecule. HHO stands for 2 parts Hydrogen & 1 part Oxygen. When 2 Hydrogen atoms are bound to 1 Oxygen atom you have water, but when we separate the atoms from each other you have Hydrogen & Oxygen mixed gas. The correct term for this gas is Oxyhydrogen

4.4.2 Dryer: HHO filter/dryer removes all unwanted particles and moisture from HHO before it enters the engine. This results in a better performing engine with less maintenance. It comes complete with 1 micron filter and standard 0.6 cm hose fittings.

4.4.2 Pulse Width Modulation: Pulse width modulation (PWM) is used for controlling amplitude signals in order to control devices and applications requiring power or electricity. It essentially controls the amount of power, in the perspective of the voltage component that is given "on" phase or duty cycle. To the device, this would appear as a steady power input with an average voltage value, which is the result of the percentage of the on time. The duty cycle is expressed as the percentage of being fully (100%) on.
A very powerful benefit of PWM is that power loss is very minimal. Compared to regulating power levels using an analog potentiometer to limit the power output by essentially choking the electrical pathway, thereby resulting in power loss as heat, PWM actually turns off the power output rather than limits it. Applications range from controlling DC motors and light dimming to heating elements.

4.4.4 Carburetor: A carburetor is a device that mixes air and fuel for internal combustion engines in the proper ratio for combustion. It is sometimes colloquially shortened to carb in the UK and North America or carby in Australia. To carburet (and thus carburation or carburetion, respectively) means to mix the air and fuel or to equip (an engine) with a carburetor for that purpose.

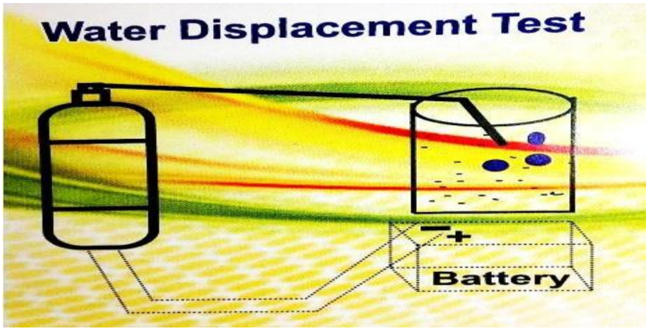
4.4.5. Hose Pipe: A hose is a flexible hollow tube designed to carry fluids from one location to another. Hoses are also sometimes called pipes or more generally tubing. The shape of a hose is usually cylindrical (having a circular cross section). Hose design is based on a combination of application and performance. Common factors are size, pressure rating, weight, length, straight hose or coil hose, and chemical compatibility.

4.4.6 Air Filter: A particulate air filter is a device composed of fibrous materials which removes solid particulates such as dust, pollen, mould , and bacteria from the air. Filters containing an absorbent or catalyst such as charcoal (carbon) may also remove odors and gaseous pollutants such as volatile organic compounds or ozone. Air filters are used in applications where air quality is important, notably in building ventilation systems and in engines.

4.4.7 Installation Method of HHO Kit:
Step 1:
Take 150ml DM water (zero TDS water) and mix electrolyte pills according to the bike power chart and fill it in the top of the blue color nozzle with the help of syringe.
Bike Power Chart

Bike Power	Tablets to add	Bubble per second
90cc to 125cc	12 tablets	1 bubble
125cc to 150cc	15 tablets	2 bubbles

Step 2:
Connect the cell's negative (black) and positive (red) wire directly to the battery terminals, for testing the kit working. Connect the pipe top of the water tank and dip this second in the water. If the HHO bubbles are coming then your kit is working fine and ready to install.



Step 3:
Find a suitable space in your vehicle, where it can be fixed easily. Don't fix it near the engine where heat can harm it.
Step 4:
Connect the PWM dR wire in cell's Black wire. Now connect the White PWM Wire to vehicle's earth (anywhere in the body) and PWM yellow positive to vehicle's IGNITION (Mean when you open key then kit will start working and when you switch off bike key, kit will stop working).Take a water displacement test and check it and make sure kit is working.
Step 5:
Now connect pipe at the top of the kit and the other side of pipe will connect in dryer, now take another pipe and connect it in dryer another nozzle. Now the output pipe of the dryer will be left.
Step 6:
Make a small hole in your Hose pipe (pipe between carburetors and air filter) and intake the pipe coming from dryer's output.
Step 7:
Start the bike for 10 minutes. Now make the carburetor's mixture setting again and set it as its minimum level (maximum air and minimum petrol). Now your installation is complete.

4.5 Implementation to the Engine

No hardware modification in the engine is required for the supply of oxyhydrogen gas. Only an inlet is to be given for the entry of the gas into the combustion chamber. In S.I engine the inlet is given after the air cleaner and before the carburetor, so that the oxyhydrogen gas will get sufficient time to adhere the fuel molecules. Thus the oxyhydrogen gas is brought inside the combustion chamber just because of engine suction pressure. Thus the oxyhydrogen usage is compatible with any of the running engine. Bike battery acts as electrical power source to the dry cell. The end plates of dry cell are connected to the bike battery with two insulated wires. The contact between wires and also wire with adjacent plate must be prevented. This leads to spark and thus causing the explosion of generator.

5.0 RESULTS AND DISCUSSIONS

5.1 RATE OF OXYHYDROGEN GENERATED:

Rate of oxyhydrogen generated is measured by number of bubbels produced per second and time taken for refilling the kit with water solution . number of bubbles produced is depend upon rate of current flow we connected the kit to 110cc bike battery it is observed that 2 bubbles are producing per second and refilling of water in kit is required for every 750km

5.2 FUEL EFFICENCY:

Only Petrol: Initially mileage has been checked while using only petrol as the fuel. It is checked for 1000ml of petrol for 3 times. Each time for every 300 ml the bike travelled almost 45 km.

Petrol + Oxyhydrogen: When mileage is checked with Oxyhydrogenand Petrol blend in the same way as above it travelled nearly about 59 km each time i.e. for every 1000ml of petrol. When petrol blend with Oxyhydrogen is injected into the combustion chamber the bike ran 15 km more than that with only petrol for every 1000 ml. This means there may be a leap of approximately 15 km for every liter of petrol, when blend is injected in to the combustion chamber.

5.3. Exhaust Gas Analysis:

Parameter	Only Petrol	Petrol + HHO
CO	15%	1.813%
CO2	20%	3.43%
HC	18973PPM	4096PPM
NOX	46PPM	33PPM
SOX	469	195

Before installing the kit
The observed mean values of the emissions are
CO: 15%
HC: 18973ppm
CO2: 20%
NOX: 46PPM
SOX: 469PPM

After installing the kit
The observed mean values of the emissions are
CO: 1.813%
HC: 4026PPM
CO2: 3.43%
SOX: 195PPM
NOX: 33PPM

An exhaust gas analyzer is used for analyzing gases and percentage of CO, NOx and other HC gases that are released from the engine during the test.At high speed conditions, short opening time of manifolds prevents adequate air to be taken into the cylinder and petrol fuel cannot be burned sufficiently. Short quenching distance and wide flammability range of hydrogen yield engine to expel less HC emissions. Besides, oxygen index of oxyhydrogen yields better combustion which diminishes HC emission.

Absence of carbon in oxyhydrogen gas is a major reason for CO reduction. Wide flammability range and high flame speed of Oxyhydrogen ensure engine to be operated at low loads. The HHO and petrol fuel mixture burns faster and more completely than the pure petrol fuel operation. Thus, CO emission at high speed and lean conditions is effectively reduced after HHO addition. Since HHO gas contains oxygen, higher combustion efficiency is obtained and increment for CO emission is slower unless HHO flow rate is diminished to appropriate flow rate values while approaching low speeds. The oxygen generated by HHO systems could theoretically reduce emissions for the same reason they may improve fuel economy.

More oxygen in the cylinders more thoroughly combust the fuel, so there are fewer unburned hydrocarbons exiting the tailpipe. Another aspect to consider is that the HHO actually displaces some of the natural air that would otherwise enter the cylinder. Earth's atmosphere contains 78 percent nitrogen, which converts into harmful nitrogen oxides (NOx) emissions in the cylinder. Less normal air means less nitrogen in the cylinder, meaning there is a very real possibility that HHO generators could help to reduce NOx (nitrogen oxide) emissions.

A small amount of hydrogen added to the intake air-fuel charge permits the engine to operate with leaner air to-fuel mixture than otherwise possible. As the air/fuel mix approaches 30:1 the temperature of combustion substantially decreases effectively mitigating NOx production. From the result obtained from emission test it is observed that NOx emissions increased. The possibilities may be lean air fuel mixture or it is reasonable to conclude that combustion chamber deposits are contributing to excessive emissions. NOx emissions are highly toxic. It causes adverse environmental effects. It is quite necessary to reduce NOx. This can be done by EGR.

Exhaust Gas Recirculation (EGR) is NOx reduction technique. EGR works by recirculating a portion of an engine's exhaust gas back to the engine cylinders. In a gasoline engine, this inert exhaust displaces the amount of combustible matter in the cylinder. Because NOx forms primarily when a mixture of nitrogen and oxygen is subjected to high temperature, the lower combustion chamber temperatures caused by EGR reduces the amount of NOx the combustion generates.

6.0 CONCLUSIONS

Oxyhydrogen gas has been generated by electrolysis. The alternative fuel is mixed with fresh air and petrol before entering the combustion chamber. Fuel efficiency and emission levels are the parameters that are observed.

It is easy to integrate the oxyhydrogen gas with existing system. No major hardware change is require.

Uniform and improved mixing of Oxyhydrogen with air and oxygen content of HHO stimulate combustion which has a major effect on SFC by using an adequate capacity system.

Oxygen content and absence of carbon make HHO gas an appropriate fuel addition to obtain adequate combustion which yield reputable reduction of HC and CO emissions.

Increase in mileage approximately by 20 km.

Reduction in harmful pollutants like nitrogen oxides and sulphur oxides from the IC Engine.

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